

# *Analytic Hierarchy Process Method for Selecting the Place to Build Supermall*

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**Abstract**— Determining the construction of area a Supermall is not easy for an investor for determine the exact location where in future will provide a high level of visitors and has a substantial return to investors for a long time. If this is not done properly it can be imagine that Supermall with its huge size and certainly has a big enough it should be costly as well if it is loss, it can be imagined how wasting such large funds could not give returnable for the perfect benefit to owners that need carefully in making investment decisions for the development Supermall. Method Analytic Hierarchy Process (AHP) method is one of the smart method to predict and determine before Supermall is built and can anticipate minimizing mistakes in decision-making by using Expert Choice software. Analytical results which obtained by using the **criteria's for this problem** decide the best choice for location is " A " location for the construction Supermall.

**Keywords:** *supermall, AHP; expert choice; decision making; criteria*

## I. INTRODUCTION

In this 20th century the business world started to rise again to conduct business in everywhere, the movement is no exception in Supermall development business , almost every Supermall in urban areas is increasing and no shortage of the number of visitors who come to it year by year, they spend their money there, for the Supermall investor the field of this is still a good opportunity to invest in renting space per room and meter per meter of land in the Supermall, then by bringing the famous supermarket the investor will absorb the visitors will only shopping in one day and one place, spend time with families in several booths of games and movies so that all who want to enjoy the game available only at one place in the Supermall. Broadly speaking, the criteria that will be used to determine area of land that must be available in acre, electricity and water, access roads, prices, population density, the response of community, other public facilities and legality are available.

Using the AHP method to determine of the right place to build a supermall will take easily where it should give the goal

first on the top layer of the structure then the sub criteria put in under the first layer and they connected each other and the alternatives put the third layer of the structure. in the criteria used pairwise comparison held by comparison matrix will be obtained compared with the index value consistency to control decision-making has a level of high consistency. basically, AHP procedure will include the following steps: defining the hierarchy structure, the problem to be solved, do weighting on each criteria level of the hierarchy, counting priorities weighted (weighted priority) and consistency weighting, showing the order / ranking of the alternatives is considered.

## II. ANALYTIC HIERARCHY PROCESS

Analytical Hierarchy Process (AHP) is a method of smart in choosing activities that compete or many alternatives based on certain criteria. The criteria may be quantitative or qualitative, AHP structure is a model of a tree hierarchy structure best with one goal to goal at the top of the structure that represents the purpose of the decision problem, one hundred percent of the weight of the decisions and just below that is the point of converting the objective criteria, either qualitative and quantitative data. The weight goal should be divided between the points criteria based on rating. The weight of each criterion is 100% divided by the weight of the points criteria based on rating. Each alternative compared to each criterion. Based on observations and a survey of the public, investors can do the analysis criteria using AHP As with decision making tool. In this study, there are eight possible criteria The description of each criteria is as follows:

- Land area, it is necessary to plan accurately to the planned establishment Supermall building with an area of 11,000 m<sup>2</sup>, the whole land is 15.000m<sup>2</sup>, (1.5 ha). Able to develop the building next to the parking area.
- Electricity and water, availability of electricity and water is crucial because during normal operational use government power but will automatically switch to the generator if the power supply dies.
- Access roads, can reach from any direction and terminals.
- Prices, the total construction price affordable to investors.

- Population density, it is also one of the criteria for investors because of the many people around the area give the guarantee will positive.
- Community feedback, the survey says that nearly 95% stated that they agreed Supermall built its region in order to facilitate the shopping, close and cheap.
- Public facilities, such as hospitals, shopping malls, parks, schools, public transport.
- Licensing and Legality, ease of handling permit letters from local governments.

AHP is generated by weighting factor in order to obtain weight which will be illustrate the relative importance of the size of an element compared to others. Examples of evaluation consisting of n elements by pairwise comparisons metrics written as follows:

$$\begin{pmatrix} W_1 & W_1 & W_1 \\ W_1 & W_2 & \dots & W_n \\ W_2 & W_2 & \dots & W_2 \\ W_1 & W_2 & \dots & W_n \\ \dots & \dots & \dots & \dots \\ W_n & W_n & \dots & W_n \\ W_1 & W_2 & \dots & W_n \end{pmatrix}$$

To be consistent in comparison, the value of the inverse of the two elements being compared are put in a position appropriate in the opposite direction. Selection and prioritization in the consistency ratio is done by eigenvector and eigenvalue counting through matrix operations. Eigenvector determine the ranking of the alternative chosen, while the eigenvalue gives a measure of the consistency of the benchmarking process. Ranking basically represented by the priority vector, as a result of the major eigenvector normalization. It is derived from the calculation of the column vector (vj) by the following equation:

$$V_j = K_{ij} \times w_i \quad (1)$$

Where the  $K_{ij}$  is the matrix with this model:

$$\begin{pmatrix} W_{11} & W_{12} & \dots & W_{1p} \\ W_{21} & W_{22} & \dots & W_{2p} \\ \vdots & \vdots & \ddots & \vdots \\ W_{n1} & W_{n2} & \dots & W_{np} \end{pmatrix}$$

with the goal (objective)  $I = (1, 2, 3, \dots, n)$ , alternative  $j = (1, 2, 3, \dots, p)$ , and  $W_{11}$  is the weight of alternative 1 for goals 1, p represents the number of alternative, and n is the number of goals.

### III. METHODOLOGY

In this study, the main objective is to be determined the accuracy of selecting the construction site Supermall to see some of the criteria used for consideration. In Figure 1 is an hierarchy process goals expected.

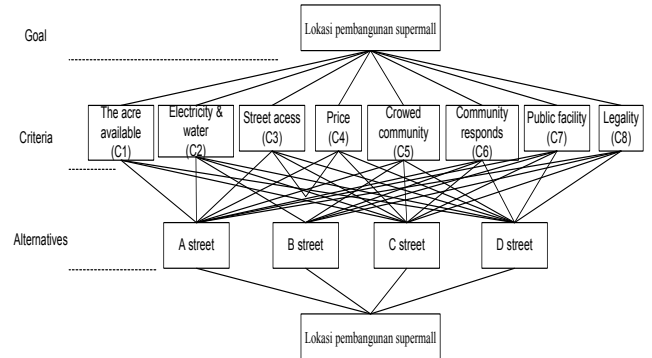


Fig 1. Hierarchy criteria with the alternatives

From Figure 1 above it could then proceed to the stage of doing a comparison against the criteria for priority setting. Determining the location to determine the degree of interest. Matrix comparison criteria (pairwise comparison matrices) could be seen in Figure 2.

C1	C2	C3	C4	C5	C6	C7	C8
1	2	6	4	7	4	5	3
1/2	1	3	5	5	6	4	5
1/6	1/3	1	4	5	6	3	4
1/4	1/5	1/4	1	5	6	2	7
1/7	1/5	1/7	1/5	1	6	3	6
1/4	1/6	1/6	1/6	1/6	1	4	2
1/7	1/4	1/3	1/2	1/4	1/2	1	5
1/3	1/5	1/4	1/7	1/6	1/2	1/5	1

Fig 2. Comparison matrix

It appears that C5 (crowded community) and C3 (Street access) is critical to more important 7 and 6 times other interests.

Table 1. Saaty Rating Scale

Intensity Of Importance	Definition	Explanation
1	Equal importance	Both element compare to have the same effect
3	Weak importance of one over another	Experience and judgment greatly favor one element compared to partner
5	Essential or strong	(more importantly) One element compare to is very

	importance	popular and very real practical dominance, compared with elements of partner
7	Demonstrated importance	One element compare to proved to be very popular and very practical dominance, compared with elements of partner
9	Extreme importance	One element compare to is absolutely preferable to his partner, the highest level of confidence
2, 4, 6, 8, Intermediate values between the two adjacent judgments		

The distinguishes with the other method is the lack of absolute consistency requirement. Polls among the other factors that are independent with each other, and this can lead to inconsistencies in the answers given respondent. However, too much inconsistency is also undesirable. Repetition of the interview on the same number of respondents sometimes necessary if the degree of consistency is not great. Consistency Index or  $\lambda_{max}$  matrix can be obtained by the formula:

$$CI = \frac{(\lambda_{max} - n)}{(n - 1)}$$

$CI$  = Ratio deviasi of *consistency index* and

$\lambda_{max}$  = Eigen value, the biggest matrix with  $n$

that the judgements are at the limit of consistency though CRs  $> 0.1$  (but not too much more) have to be accepted sometimes. In this instance, we are on safe ground.

AHP Calculation, There are several methods for calculating the eigenvector. Multiplying together the entries in each row of the matrix and then taking the  $n$ th root of that product gives a very good approximation to the correct answer. The  $n$ th roots are summed and that sum is used to normalise the eigenvector elements to add to 1.00. In the matrix below, the 4<sup>th</sup> root for the first row is 0.293 and that is divided by 5.024 to give 0.058 as the first element in the eigenvector. The table below gives a worked example in terms of four attributes to be compared which, for simplicity, we refer to as A, B, C, and D.

Table. 2. Attribute Compare

	A	B	C	D	$n$ th root of product of values	Eigenvector
A	1	1/3	1/9	1/5	0.293	0.058
B	3	1	1	1	1.326	0.262
C	9	1	1	3	2.279	0.454
D	5	1	1/3	1	1.236	0.226
Total					5.024	1.000

The eigenvector of the relative importance or value of A, B, C and D is (0.058,0.262,0.454,0.226). Thus, C is the most valuable, B and D are behind, but roughly equal and A is very much less significant. The next stage is to calculate  $\lambda_{max}$  so as to lead to the Consistency Index and the Consistency Ratio.

We first multiply on the right the matrix of judgements by the eigenvector, obtaining a new vector. The calculation for the first row in the matrix is:  $1*0.058+1/3*0.262+1/9*0.454+1/5*0.226 = 0.240$  and the remaining three rows give 1.116, 1.916 and 0.928. This vector of four elements (0.240,1.116, 1.916,0.928) is, of course, the product  $A\omega$  and the AHP theory says that  $A\omega=\lambda_{max}\omega$  so we can now get four estimates of  $\lambda_{max}$  by the simple expedient of dividing each component of (0.240,1.116,1.916,0.928) by the corresponding eigenvector element. This gives  $0.240/0.058=4.137$  together with 4.259, 4.22 and 4.11. The mean of these values is 4.18 and that is our estimate for  $\lambda_{max}$ . If any of the estimates for  $\lambda_{max}$  turns out to be less than  $n$ , or 4 in this case, there has been an error in the calculation, useful sanity check. The Consistency Index for a matrix is calculated from  $(\lambda_{max}-n)/(n-1)$  and, since  $n=4$  for this matrix, the CI is 0.060. The final step is to calculate the Consistency Ratio for this set of judgements using the CI for the corresponding value from large samples of matrices of purely random judgments using the table below, derived from Saaty's book, in which the upper row is the order of the random matrix, and the lower is the corresponding index of consistency for random judgements [5].

If the CI is zero, then the pair wise comparison matrix is consistent. Limit inconsistency (inconsistency) that have been established by Thomas L. Saaty determined using Consistency Ratio (CR), which is the ratio index. consistency with a random value index (RI) were obtained an experiment by the Oak Ridge National Laboratory later developed by the Wharton School and is shown as Table 3. This value depends on the matrix order  $n$ .

Table 3. Random Value Index

n	1	2	3	4	5	6	7	8	9
RI	0,00	0,00	0,580	0,900	1,0120	1,240	1,320	1,410	1,450
n	10	11	12	13	14	15			
RI	1,490	1,510	1,480	1,560	1,570	1,590			

If the pairwise comparison matrices with CR values less than 0.1 then the inconsistency of the decision maker than is acceptable if it does not then need to be repeated assessments again.

For example, that gives  $0.060/0.90=0.0677$ . Saaty argues that a  $CR > 0.1$  indicates

## IV. APPLICATION

Analytic Hierarchy Process (AHP) is the expert method to Determine the objective of the cases in this research has the purpose Which how to take the right decision to the right position to build the Supermall in the area of the town. The initial phase is to determine the variable preparation followed by making questioner for determining the weight especially on the community and the other responds well then create and set the value of each criterion and calculate the value hierarchy based on the priority selection criteria weight multiplication.

Table 3. Pairwise Comparison Matric

B.F	Elt	Acs	Price	Crd	Resp	Pub	Leg
Area	3	8	7	9	3	6	6
Elt		3	3	2	2	5	3
Acs			3	2	2	2	3
Price				3	3	2	3
Crd					3	3	3
Resp						3	5
Pub							2

Note : Elt=Electric; Area ; Acs=Acess; Price=Price; Crd = Crowded; Resp = Respond Community; Pub=Public respond.

From the matrix pairwise comparison should be calculated the aigen value and With the software it should be the final result as follow :

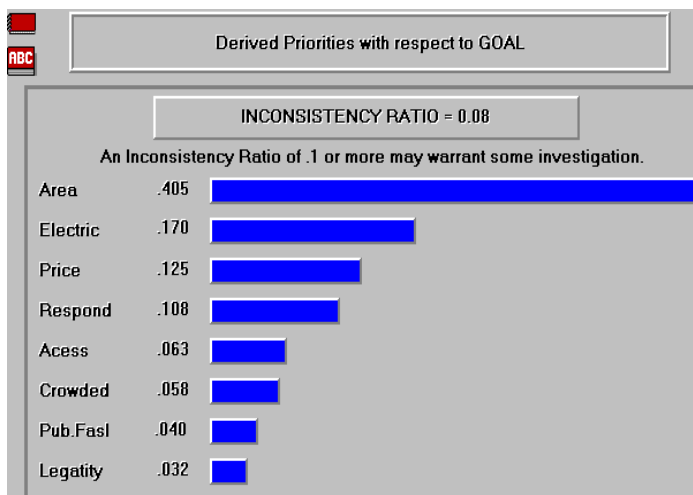
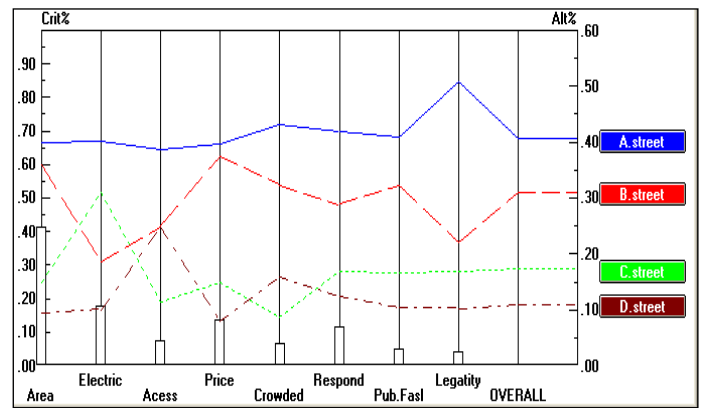


Fig 3. The Final result of the ranking variables with Inconsistency Ratio = 0,008.



Note: Blue, Red, Green and Brown are the alternatives A,B,C,D respectively.

Fig. 4. The line graph that shown from the high rank.

From the final result the investor should decide the supermall should be built “A-Street” than the others, it means that is the best chosen from the forth alternatives.

Every delivery five criteria from the graft tell us that there have 8 point criteria area there, it should be in range Area and electric have 2 area, between electric to access area they have 3 cross lines and from access to price it has one cross line, from price to crowded and rowed to respond they have one cross line respectively. Those classify are (1).  $SA > SB > SC > SD$ ; (2).  $SA > SC > SB > SD$ ; (3).  $SA > SC > SD > SC$ ; (4).  $SA > SB > SD > SC$ ; (5).  $SA > SB > SC > SD$ . (6).  $SA > SB > SD > SC$ .(7).  $SA > SB > SD > SC$ . (8).  $SA > SB > SC > SD$  and the value each classification should be shown in the fig.4. above.

## V. CONCLUSION

By using AHP application to predict construction of a Supermall is the right step to avoid losses of money that were never considered before this method helps the investor to calculate the alternative comparisons could be done more quickly and accurately. With the number of alternatives which many comparisons can be calculated simultaneously and optimally, so as to provide a solution in the form of alternative decisions for an investor. By looking at the above results, it should be arranging the variables in ascending rank as follow: area, electric, price, community respond, access, Crowded area, public facility and legality. The final result for the investor that should think that a very prospective area could be built the supermall in an “A-street” for the best chosen from the forth alternatives.

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